

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently amended) A lead-free joining material, comprising:
 - (a) a core part including zinc and tin as major components and at least any one of bismuth and germanium as an additive element; and
 - (b) a surface layer covering the core part and including the major components and the additive element, the surface layer including:
 - (i) a solid-solution phase in which a concentration of the additive element is higher than a concentration of the additive element in the core part, and the concentration of the additive element in the solid-solution phase is in a range of 0.6 % to 4.0 % by weight; and
 - (ii) a needle crystal which is more than a core part, is dispersed in the solid-solution phase and includes the zinc as a main component.
2. (Currently amended) The lead-free joining material according to claim 1,
wherein the concentration of the additive element in the core part is in a range of 0.3 % to 1.0 % by weight.
3. (Currently amended) The lead-free joining material according to claim 1,
wherein the surface layer has a depth of at least 2 μm [.,m] from an outermost surface.
4. (Original) The lead-free joining material according to claim 1,
wherein the lead-free joining material is a particle which is substantially spherical.
5. (Currently amended) The lead-free joining material according to claim 1,
wherein an average concentration of the additive element in the whole lead-free joining material is in a range of 0.6 % to 1.0 % by weight.
6. (Currently amended) A lead-free solder paste, comprising:
 - (A) a lead-free joining material, including:

(a) a core part including zinc and tin as major components and at least any one of bismuth and germanium as an additive element; and

(b) a surface layer covering the core part and including the major components and the additive element, the surface layer including;

(i) a solid-solution phase in which a concentration of the additive element is higher than a concentration of the additive element in the core part, and the concentration of the additive element in the solid-solution phase is in a range of 0.6 % to 4.0 % by weight; and

(ii) a needle crystal which is more than a core part, is dispersed in the solid-solution phase and includes the zinc as a main component; and

(B) a flux.

7. (Currently amended) The lead-free solder paste according to claim 6,

wherein the concentration of the additive element in the core part is in a range of 0.3 % to 1.0 % by weight.

8. (Currently amended) The lead-free solder paste according to claim 6,

wherein the surface layer has a depth of at least 2 μm [.,m] from an outermost surface.

9. (Original) The lead-free solder paste according to claim 6,

wherein the lead-free joining material is a particle which is substantially spherical.

10. (Currently amended) The lead-free solder paste according to claim 6,

wherein an average concentration of the additive element in the whole lead-free joining material is in a range of 0.6 % to 1.0 % by weight .

11. (Currently amended) A joining method using a lead-free joining material, comprising:

coating a solder paste to a connection, the solder paste being formed by blending the lead-free joining material and a flux, and

reflowing the solder paste,

wherein the lead-free joining material includes:

(a) a core part including zinc and tin as major components and at least any one of bismuth and germanium as an additive element; and

(b) a surface layer covering the core part and including the major components and the additive element, the surface layer including;

- (i) a solid-solution phase in which a concentration of the additive element is higher than a concentration of the additive element in the core part, and the concentration of the additive element in the solid-solution phase is in a range of 0.6 % to 4.0 % by weight; and
- (ii) a needle crystal which is more than a core part, is dispersed in the solid-solution phase and includes the zinc as a main component.

12. (Currently amended) The joining method according to claim 11,
wherein the concentration of the additive element in the core part is in a range of 0.3 % to 1.0 % by weight .

13. (Currently amended) The joining method according to claim 11,
wherein the surface layer has a depth of at least 2 μm [.,m] from an outermost surface.

14. (Original) The joining method according to claim 11,
wherein the lead-free joining material is a particle which is substantially spherical.

15. (Currently amended) The joining method according to claim 11,
wherein an average concentration of the additive element in the whole lead-free joining material is in a range of 0.6 % to 1.0 % by weight.

16. (Currently amended) A joining method using a lead-free joining material, comprising:
placing the lead-free joining material on a connection pre-coated with a flux; and
reflowing the flux and the lead-free joining material,
wherein the lead-free joining material includes:

- (a) a core part including zinc and tin as major components and at least any one of bismuth and germanium as an additive element; and
- (b) a surface layer covering the core part and including the major components and the additive element, the surface layer including;
 - (i) a solid-solution phase in which a concentration of the additive element is higher than a concentration of the additive element in the

core part, and the concentration of the additive element in the solid-solution phase is in a range of 0.6 % to 4.0 % by weight; and

(ii) a needle crystal which is more than a core part, is dispersed in the solid-solution phase and includes the zinc as a main component.

17. (Currently amended) The joining method according to claim 16,
wherein the concentration of the additive element in the core part is in a range of 0.3 % to 1.0 % by weight .
18. (Currently amended) The joining method according to claim 16,
wherein the surface layer has a depth of at least 2 μm [.,m] from an outermost surface.
19. (Original) The joining method according to claim 16,
wherein the lead-free joining material is a particle which is substantially spherical.
20. (Currently amended) The joining method according to claim 16,
wherein an average concentration of the additive element in the whole lead-free joining material is in a range of 0.6 % to 1.0 % by weight.
21. (New) A lead-free joining material, comprising:
zinc and tin as major components, and at least any one of bismuth and germanium as an additive element, wherein an average concentration of the additive element in the lead-free joining material is in a range of 0.6 % to 1.0 % by weight.
22. (New) A method of making a lead-free joining material, comprising:
melting tin, zinc, and at least any one of bismuth and germanium as an additive element to form a molten liquid;
forming the molten liquid into droplets; and
solidifying the droplets into particles;
wherein the particles include:
(a) a core part that includes zinc and tin as major components and at least any one of bismuth and germanium as an additive element; and

(b) a surface layer covering the core part that includes the major components and the additive element, the surface layer including;

- (i) a solid-solution phase in which a concentration of the additive element is higher than a concentration of the additive element in the core part, and the concentration of the additive element in the solid-solution phase is in a range of 0.6 % to 4.0 % by weight; and
- (ii) a needle crystal which is dispersed in the solid-solution phase and includes the zinc as a main component.

23. (New) The lead-free joining material produced by the process of claim 22.